



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**APPLICATION OF A UNIFORM PRICE QUALITY
ADJUSTED DISCOUNT AUCTION FOR ASSIGNING
SURFACE WARFARE OFFICER RETENTION BONUSES**

by

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March 2012

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AUCTION FOR ASSIGNING SURFACE WARFARE OFFICER RETENTION
BONUSES**

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ABSTRACT

This thesis analyzes the potential benefits of implementing a unique auction model that provides community and compensation managers with the ability to control for the quality and quantity of sailors retained. The study utilizes survey data to estimate officers' preference parameters and compare the cost, quantity and quality of Surface Warfare Officers (SWO) retained by the current SWO bonus, a standard uniform-price auction, and a quality adjusted discount (QUAD) auction.

The results demonstrate efficiency improvements over the current retention system. The thesis supports the findings from previous research on QUAD auctions, and confirms the hypothesis that increases in quality do not necessarily create cost increases.

Findings from this thesis can be used in future retention and compensation policies to more cost effectively shape the force while maintaining or enhancing quality.

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LIST OF ACRONYMS AND ABBREVIATIONS

AVF	All-Volunteer Force
DH	Department Head
DIVO	Division Officer
DoD	Department of Defense
EOOW	Engineering Officer of the Watch
FITREP	Fitness Report
GPA	Grade Point Average
GSA	Global War on Terror Support Assignment
IA	Individual Augmentee
IRB	Institutional Review Board
JCRSB	Junior Surface Warfare Officer Critical Skills Retention Bonus
NPS	Naval Postgraduate School
OOD	Officer of the Deck
PDR	Personal Discount Rate
PRT	Physical Readiness Test
QUAD	Quality Adjusted Discount
SWO	Surface Warfare Officer
SWOCP	Surface Warfare Officer Continuation Pay
TAO	Tactical Action Officer
U/W	Underway
YCS	Years of Commission Service
YOS	Years of Service

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I. INTRODUCTION

A. BACKGROUND

In a period of increased fiscal scrutiny and imminent budget cuts, the Department of Defense (DoD) is facing significant budget cuts over the next decade and beyond. As manpower and equipment costs continue to rise, the DoD is under pressure to find cost savings while maintaining capabilities, readiness, and effectiveness. In addition, the DoD is expected to face increased manning challenges as the economy recovers and the all-volunteer force (AVF) is forced to compete harder with the private sector for quality personnel.

Each branch of the DoD employs some version of enlistment or retention bonuses to meet manning requirements. The Navy uses a combination of bonuses to retain Surface Warfare Officers (SWOs), the Junior Officer Critical Skills Retention Bonus (JCRSB) and Surface Warfare Officer Continuation Pay (SWOCP)—commonly referred to together as the “SWO Bonus”—totaling \$75,000.00, to meet its retention goals. Even with the large bonus and recent tougher economic times, the Navy perennially struggles to meet its goal of 275 SWOs retained for Department Head (DH) tours. This presents challenges both the slating and recruiting process for the manpower community.

B. PURPOSE

The purpose of this research is to analyze the benefits of the Navy incorporating a unique auction model to assign the SWO Bonus. The study examines the feasibility and potential cost savings of utilizing a Quality Adjusted Discount (QUAD) Auction that provides the ability to control for the quality and quantity of sailors retained. The study uses a survey of former, current, and future SWO Bonus-eligible officers to compare the current system against a standard uniform-price auction and a QUAD Auction mechanism by evaluating the cost and quality of officer retained of each system. Results from this thesis could be used in the future to more cost effectively shape the force while maintaining or enhancing quality.

C. RESEARCH QUESTIONS

- Estimate preference parameters (reservation value, outside option, etc.) of the service members.
- Examine the potential cost savings from the Navy's utilization of a QUAD Auction to assign the SWO Bonus.
- Explore the impact of a QUAD Auction on the quality of officers retained by the Navy through Surface Warfare Officer Bonus—the Surface Warfare Officer Continuation Pay (SWOCP) and Junior Officer Critical Skills Retention Bonus (JCRSB).

D. THESIS SCOPE AND METHODOLOGY

This thesis focuses on Naval Officers eligible to receive the SWO Bonus. The scope includes: (1) analyze military pay and incentives, specifically SWOCP and JCRSB, (2) review basic auction theory and the QUAD model, (3) develop a survey to estimate parameters for the QUAD auction mechanism in the military labor market, (3) develop a process for scoring quality of officers, and (4) compare costs of the current SWO Bonus with auction simulations.

II. MILITARY COMPENSATION OVERVIEW

A. BASE PAY

A servicemember's base pay is based specifically on rank and years of service (YOS), and determined using pay tables updated annually. It is the same across all branches of service and for all Military Operational Specialties (MOS) or warfare designators. Base pay constitutes approximately 50 percent of a servicemember's monetary compensation.

B. ALLOWANCES

In addition to base pay, eligible servicemembers receive housing, subsistence, and other allowances (Defense Travel Management Office, n.d.).

1. HOUSING ALLOWANCES

Servicemember housing benefits range from government-provided housing to a tax-exempt housing allowance, or some combination of the two, depending on the duty station. Servicemembers are eligible to receive Basic Allowance for Housing (BAH) to offset the cost of housing. Servicemembers have the option of military housing or civilian quarters. Members residing in military housing forego part or all of their BAH depending on the housing they are in:

The Basic Allowance for Housing (BAH) is a U.S. based allowance prescribed by geographic duty location, pay grade, and dependency status. It provides uniformed Service members equitable housing compensation based on housing costs in local civilian housing markets within the United States when government quarters are not provided. (Defense Travel Management Office, n.d.)

2. BASIC ALLOWANCE FOR SUBSISTENCE

The Basic Allowance for Subsistence (BAS) is meant to offset the cost of meals. It is a flat amount based on the United States Department of Agriculture (USDA) food cost index.

3. ADDITIONAL ALLOWANCES

- Cost of Living Allowance (COLA): Paid in designated non-contiguous locations
- Overseas Housing Allowance (OHA): Paid overseas in lieu of BAH
- Family Separation Allowance (FSA): Paid to servicemembers geographically separated from their dependents for thirty days or more.

C. RETIREMENT

Over the long term, retirement benefits make up a sizeable portion of a servicemember's compensation package. Servicemembers become vested after twenty years of service. Officers are paid an annuity of 2.5-percent per year of service (capped at thirty years) times the average of the highest three years of the member's basic pay.

D. BONUS PROGRAMS

Servicemembers are paid a variety of special and incentive pays depending on their warfare designator. This thesis specifically focuses on Surface Warfare Officer retention, and will consider Surface Warfare Officer Continuation Pay (SWOCP) and Junior Surface Warfare Officer Critical Skills Retention Bonus (JSCRB), known together as the SWO Bonus, which are paid for completing two SWO department head afloat tours.

1. SURFACE WARFARE OFFICER CONTINUATION PAY

SWOCP is an incentive pay intended to assist the SWO community manager in meeting its retention goal, 275 department heads. Currently, SWOCP pays a total of \$50,000 spread over three to seven years, depending on when it is accepted (Navy Personnel Command, SWOCP).

2. JUNIOR SURFACE WARFARE OFFICER CRITICAL SKILLS RETENTION BONUS

JSCR B is a \$25,000 retention bonus paid separately from SWOCP. JSCR B is paid to eligible O3's in return for a commitment to remain on active duty through nine years of commissioned service or two department head tours. It is paid out over the course of three years (Navy Personnel Command, Junior SWO CSRB).

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III. INTRODUCTION TO BASIC AUCTIONS

A. BACKGROUND

Auctions are one of the oldest and most efficient market mechanisms used to sell goods and services. They date as far back 500 B.C, and are currently used to sell everything from goods and services, such as livestock and real estate, to mineral rights, government contracts, treasury bills, and frequency spectrum rights (Milgram, 2004). Modern economists define auctions as, “an economic mechanism whose purpose is the allocation of goods (or services) and the formation of prices for those goods (or services) via a process known as bidding (Henderson, 2007, p. 21). The role and strategy of participants is dependent on the type of auction being conducted, and the value each places on the object up for auction.

B. AUCTION VOCABULARY AND TERMINOLOGY

While auctions can differ slightly depending on the object, rules, and type of auction used, they all share a common terminology. The following consists of a compilation of theses conducted at the Naval Postgraduate School. All information is used courtesy of the following thesis authors: William N. Filip, Tony K. Verenna, and Christopher S. White.

All auctions are made up of *Bidders*, *Bid-Takers*, *Sellers*, and *Buyers*. *Bidders* are individuals or entities competing for the object up for auction. The *Bid-Takers* are the individuals or entities that receive the bids or offers from the bidders. The *Seller* is the entity in possession of the object he is willing to provide for the right price. The *Buyer* is the entity attempting to purchase the object from the seller for the lowest price possible.

A *Forward Auction* is the most common auction. It consists of a single seller offering an object to multiple buyers at the highest price he can get. This type of auction is often used for the sale of livestock, automobiles, real estate, and collectibles such as art or antiques. Multiple sellers and a single buyer, purchasing at the lowest price, constitute a *Reverse Auction*. This is frequently used in the government contracting process, and is what this study focuses on.

Both bidders and bid-takers have a valuation of the object up for auction, this is the *reservation price*. A bidder's reservation price is the maximum he is willing to pay for an item in a forward auction. The bid-taker's reservation price is the minimum he is willing to accept in a reverse auction. In some auctions, a *reserve price* is used to ensure that adequate funds are exchanged.

Bidders submit their bids in a simultaneous and independent manner in *Sealed-bid* auctions. Each bidder submits only one bid, and is unaware of what the other bidders are bidding. In *First-price* auctions the winning bid, and the price paid to the seller, is the highest bid submitted. Bidders tend to underbid their valuation in forward first-price auctions, and overbid in reverse first-price auctions. In *Second-price Sealed-bid* auctions the winner pays the price of the second highest bid (first excluded). A bidder's bid is only used to determine if he won, not necessarily the price he pays. This encourages bidders to submit a bid equal to their valuation of the object, and prevents a buyer from attempting to drive the price up or down to increase his profit or surplus.

For a more in depth explanation additional of auction theory, refer to Appendix A.

IV. QUALITY ADJUSTED DISCOUNT (QUAD) AUCTIONS

A. BACKGROUND

A standard uniform-price auction is the multiple winner version of a second-price sealed-bid auction. It is a reverse auction with a single buyer or bid-taker purchasing a good or service from multiple sellers or bidders. Sellers' sealed bids are ranked from lowest to highest. The winners are the lowest bids below the buyer's reservation value or number of bids he's willing to purchase. All winners receive a payout, equal to the first excluded bidder's price. Standard uniform-price auctions are dominant strategy incentive compatible, and encourage all sellers to bid their true reservation price.

Table 1 is an example of a standard uniform-price auction attempting to retain 8 officers, at the cheapest cost to the Navy. The cutoff bid is the 8th cheapest bid, \$9,974 in this example. Any bid below \$9,974 is retained. The first excluded bid is the 9th lowest bid, \$11,810 in this example. The winners, or retained officers, are each paid \$11,810.

Table 1. Example Standard Uniform-Price Auction

Rank	Bid	Quality Score	Retained	Bonus Paid
1	\$ 4,382.00	1	1	\$ 11,810.00
2	\$ 5,050.00	1	1	\$ 11,810.00
3	\$ 5,153.00	1	1	\$ 11,810.00
4	\$ 6,636.00	2	1	\$ 11,810.00
5	\$ 8,037.00	3	1	\$ 11,810.00
6	\$ 8,043.00	2	1	\$ 11,810.00
7	\$ 9,891.00	4	1	\$ 11,810.00
8	\$ 9,974.00	3	1	\$ 11,810.00
9	\$ 11,810.00	3	0	\$ -
10	\$ 12,161.00	4	0	\$ -
11	\$ 13,491.00	5	0	\$ -
12	\$ 14,252.00	5	0	\$ -
13	\$ 15,578.00	5	0	\$ -
14	\$ 16,070.00	5	0	\$ -
15	\$ 16,879.00	5	0	\$ -
Average Quality		Average Cost		Total Cost
2.13		\$ 6,298.67		\$ 94,480.00

B. MODEL DESCRIPTION

QUAD is an auction model developed by Myung (2011). QUAD auctions differ from standard uniform-price auctions by utilizing monetary payments to discount high quality bids. Each bidder's quality is rated, and bids from bidders with a quality rating above a buyer determined threshold are discounted. The discounted bids are re-ranked, and the winners are determined similarly to a standard uniform-price auction by comparing subsidized bids. QUAD auctions are also dominant strategy incentive compatible.

1. SELLERS

In DoD retention applications, the servicemembers represent the sellers in an auction; they are attempting to maximize their total income by submitting retention bonus bids. Each servicemember's bid represents his reservation value for remaining on active duty. The bids are sealed; each servicemember is afforded the opportunity to make one bid, made without knowledge of other competing bids. QUAD auctions are dominant incentive compatible. There is no incentive for the servicemembers to inflate their reservation values and bids, because they risk having their bid rejected. Likewise, the incentive to underbid is mitigated by the risk of being retained below their true reservation value.

2. BUYERS

The DoD represents the buyer in retention auctions. The DoD's objective is to retain a desired number of servicemembers, minimize total costs, and attempt to retain higher quality level of officers within cost constraints.

C. MODEL CONSTRUCT AND PROCESS

Bidders (O_i) are characterized by their bids (b_i), reservation values (r_i), and quality (q_i). Each bidder's goal is to maximize his or her payoff (p_i) by submitting a bid representative of true reservation value. There are N bidders participating in the auction. The buyer's goal is to retain M servicemembers. In a QUAD auction, the buyer is able to

set the minimum quality level (q^*) required to grant assistance (A) to qualified bids. After all bids are placed, the community manager calculates the quality adjusted bids (b^*).

$$b_i^* \begin{cases} b_i & \text{if } q_i < q^* \\ b_i - A & \text{if } q_i \geq q^* \end{cases}$$

The bids are then ranked from highest to lowest ($\{b_i^*\}_{i=1}^N$). The M lowest quality adjusted bids are retained. b^* is set to the $M + 1$ bid, the first excluded bid. Officers with $b_i^* \leq b^*$ are retained and receive the following payout:

$$p_i \begin{cases} b_i & \text{if } q_i < q^* \\ b_i + A & \text{if } q_i \geq q^* \end{cases}$$

In the event of a tie, the officer with the higher q_i is retained. If both officers have the same bid and same quality, both are retained. Officers rejected by the retention auction compete for their reservation value in the civilian sector.

Table 2 applies QUAD auction methodology to the previous standard uniform-price auction example. (Table 1) The bidders' reservation values and quality scores are the same for demonstration purposes. The QUAD example sets $q^* \geq 4$ and $A = \$5,500$. This means any officer with a quality score greater than or equal to 4 will have his or her bid discounted by \$5,500. The QUAD bids are ranked lowest to highest, and the cutoff bid is \$8,037. Officers with QUAD bids below \$8,037 are retained and each paid the first excluded bid, \$8,043. Officers retained with quality scores greater than or equal to 4 are paid an additional \$5,500, bringing their payout to \$13,543 each. Note that the average quality has increased over the standard uniform-price auction from 2.13 to 2.63, and the total cost has decreased from \$94,480 to \$80,844.

Table 2. Example Quality Adjusted Discount Auction

Quality Allowance		5500	$Q^* \geq$	4	Target	8
Rank	Bid	Quality Score	QUAD Bid	QUAD Rank	Retained	Bonus Paid
1	\$ 4,382.00	1	\$ 4,382.00	1	1	\$ 8,043.00
2	\$ 5,050.00	1	\$ 5,050.00	3	1	\$ 8,043.00
3	\$ 5,153.00	1	\$ 5,153.00	4	1	\$ 8,043.00
4	\$ 6,636.00	2	\$ 6,636.00	5	1	\$ 8,043.00
5	\$ 8,037.00	3	\$ 8,037.00	8	1	\$ 8,043.00
6	\$ 8,043.00	2	\$ 8,043.00	9	0	\$ -
7	\$ 9,891.00	4	\$ 4,391.00	2	1	\$ 13,543.00
8	\$ 9,974.00	3	\$ 9,974.00	11	0	\$ -
9	\$ 11,810.00	3	\$ 11,810.00	15	0	\$ -
10	\$ 12,161.00	4	\$ 6,661.00	6	1	\$ 13,543.00
11	\$ 13,491.00	5	\$ 7,991.00	7	1	\$ 13,543.00
12	\$ 14,252.00	5	\$ 8,752.00	10	0	\$ -
13	\$ 15,578.00	5	\$ 10,078.00	12	0	\$ -
14	\$ 16,070.00	5	\$ 10,570.00	13	0	\$ -
15	\$ 16,879.00	5	\$ 11,379.00	14	0	\$ -
Average Quality:			Average Cost		Total Cost	
2.625			\$ 5,389.60		\$ 80,844.00	

D. BIDDING STRATEGY

An officer's optimal bidding strategy is to truthfully reflect his reservation value for staying on active duty in his bid. For example, a servicemember participating in a QUAD retention auction has an actual reservation value of \$75,000. He can either: 1) underbid, 2) truthfully bid, or 3) overbid. Table 3 illustrates the possible outcomes from the above bidding strategies if he does not and does qualify for a \$10,000 quality assistance.

Table 3. Optimal Bidding Strategy in QUAD Retention Auction

Does not qualify for assistance ($q_i < q^*$), ($b_i^* = b_i - A$)			
Reservation Value (r_i): \$75,000	If Cutoff Bid is \$60,000 (b^*)	If Cutoff Bid is \$75,000 (b^*)	If Cutoff Bid is \$90,000 (b^*)
Underbid \$50,000 (b_i)	Retained at \$60,000	Retained at \$75,000	Retained at \$90,000
Truthfully Bid \$75,000 (b_i)	Rejected at \$75,000	Rejected at \$75,000	Retained at \$90,000
Overbid \$100,000 (b_i)	Rejected at \$75,000	Rejected at \$75,000	Rejected at \$90,000
Qualifies for assistance ($q_i \geq q^*$), ($b_i^* = b_i - A$), ($A=10,000$)			
Reservation Value (r_i): \$75,000	If Cutoff Bid is \$60,000 (b^*)	If Cutoff Bid is \$75,000 (b^*)	If Cutoff Bid is \$90,000 (b^*)
Underbid \$50,000 (b_i)	Retained at \$60,000	Retained at \$85,000	Retained at \$100,000
Truthfully Bid \$75,000 (b_i)	Rejected at \$65,000	Retained at \$85,000	Retained at \$100,000
Overbid \$100,000 (b_i)	Rejected at \$90,000	Rejected at \$90,000	Rejected at \$90,000

The portion highlighted in green is the bidder's optimal bidding strategy. A bidder will always be retained at or above his reservation value if he bids truthfully, deviating from his truthful reservation value carries the potential to produce undesirable outcomes. He risks being retained below his reservation value by underbidding. Similarly, he risks being rejected at a cutoff equal to or above his reservation value and foregoing a surplus by overbidding.

E. CHAPTER SUMMARY

QUAD auctions are reverse uniform-price auctions that function similarly to second-price sealed bid auctions. They provide buyers, Navy manpower planners in this case, the ability to control for quality in addition to quantity, while endogenously determining the minimum cost. Furthermore, QUAD retention auctions encourage

voluntary participation and bidders to bid their truthful reservation values, vice under or overbidding—bidding truthfully guarantees a payout greater than or equal to the bidder's reservation value.

V. RETENTION SURVEY

A. BACKGROUND

A survey of former, current, and future SWO Bonus-eligible officers is employed to conduct the comparison between the current SWO Bonus and QUAD Auction retention mechanisms. The survey data is used to estimate the officer's preference parameters and personal characteristics, such as reservation value or bid and quality rating. The parameters are used to simulate retaining the surveyed officers utilizing the current SWO Bonus system, a standard uniform-price auction, and a QUAD auction to analyze potential cost savings and the impact on the quality of officers retained by each mechanism.

B. SURVEY DEVELOPMENT AND DELIVERY

An online survey was developed using Survey Monkey, an online collection service. The questions were designed to determine an officer's 1) reservation value for remaining on active duty and quantify his quality or value to the Navy to facilitate a QUAD Auction, and 2) estimate his earning in the civilian labor market, personal discount rate, and identify factors influencing his propensity to remain on active duty. The survey was targeted to Surface Warfare Officers (SWO) O4 and below that were, are, or will be eligible for the SWO Bonus. A draft version of the survey was tested with a small group of Surface Warfare Officers.

Upon receiving International Review Board (IRB) approval and authorization from the Naval Postgraduate School and Commander Naval Surface Forces Pacific Fleet (COMNAVSURFPAC), a link to the study was electronically distributed. The study was open to students at the Naval Postgraduate School from February 1 to February 14, and officers stationed in the Pacific Fleet (PACFLT) from February 10 to February 24.

A copy of the survey is included in Appendix B.

C. POPULATION AND SAMPLE STATISTICS

Of the approximately 1700 officers targeted by the survey, there were 327—a response rate of 19.23%. Two hundred thirteen of the respondents failed to provide enough usable data by skipping or incompletely answering questions used to determine reservation value and quality rating. An additional six responses were dropped as statistical outliers, bringing the sample size for the retention mechanism analysis to 108.

Table 4 provides a comparison of the Navy officer population and sample statistics utilizing the 2010 Department of Defense Demographics Report. Overall, the survey sample was representative of the population. Males, Asians, O2s, and O3s were overrepresented. Females, Blacks, and O1s were underrepresented.

Table 4. Population and Sample Statistics

	Navy Officer Population*	Sample
Male	71.3%	87.0%
Female	28.7%	13.0%
White	81.4%	80.6%
Black	8.3%	2.8%
Asian	4.1%	8.3%
Other	6.2%	8.3%
O1	13.1%	4.9%
O2	12.2%	21.6%
O3	31.8%	58.8%
O4	19.5%	14.7%
Married	65.0%	61.8%
Unmarried	35.0%	38.2%

*2010 DoD Demographics Report

D. ESTIMATION OF THE PARAMETERS

The study uses the survey data to estimate the officers' bids and quality rating.

1. Bids

The survey asks, "What is the MINIMUM BONUS you would need to be offered by the Navy to commit to two Department Head Afloat tours?" The responses are used

to represent an officer's bid or reservation value for remaining on active duty. Table 5 shows the summary statistics of the officers' bids by pay grade. The median bid for O1s, O2s, and O3s is \$75,000, equivalent to the current SWO Bonus.

Table 5. Bid by Pay Grade

	Observations	Mean Bid	Median Bid	Standard Deviation
O1	5	\$ 71,000.00	\$ 75,000.00	\$ 21,330.73
O2	22	\$ 97,045.45	\$ 75,000.00	\$ 90,167.29
O3	60	\$ 86,166.67	\$ 75,000.00	\$ 68,928.65
O4	15	\$ 102,333.33	\$ 100,000.00	\$ 122,370.44
Sample	108	\$ 90,879.63	\$ 75,000.00	\$ 80,775.53

Table 6 lists the summary statistics for the bids.

Table 6. Bid Summary Statistics

Bid (b_i)	
Mean	\$ 90,879.63
Standard Error	\$ 7,772.63
Median	\$ 75,000.00
Mode	\$ 75,000.00
Standard Deviation	\$ 80,775.53
Sample Variance	\$ 6,524,686,310.14
Kurtosis	\$ 7.27
Skewness	\$ 2.24
Range	\$ 500,000.00
Minimum	\$ -
Maximum	\$ 500,000.00
Count	\$ 108.00
Largest(5)	\$ 250,000.00
Smallest(5)	\$ -
Confidence Level(95%)	\$ 15,408.33

2. Quality Rating

A bidder's quality rating is a key component of a QUAD Auction. It is used to determine whether or not an officer's bid is discounted. While the metric used for quality

rating is ultimately a policy question, it is necessary to compute quality rating for analytical purposes. This thesis examines four methods of calculating an officer's quality rating.

All four methods utilize responses from the survey to create a rating that captures an officer's personal on the job performance, qualifications, and experience. The quality ratings are calculated by adding the values from each category or metric (M_i^n) multiplied by the weight assigned (W^n), dividing by the total number of possible points (X), and multiplying by five. This creates a quality rating (q_i) on a scale of zero to five, five being the highest quality.

$$q_i = 5 \times \left(\frac{\sum_i^n W^n \times M_i^n}{X} \right)$$

The metrics and weights used for each method are explained below:

a. Quality Method 1

Quality method 1 utilizes the following metrics in its calculation:

- Total years of active duty service
- Number of deployments (longer than 90 days) completed
- Number of different platforms the officer has been stationed on
- If the officer has completed a topside and engineering tour
- Average relative score on the previous two FITREPs

An officer's relative FITREP score is calculated by dividing the individual's score by his reporting senior's cumulative average at time of reporting. This quantifies the individual's performance in relation to the reporting group average. This calculation is performed for the respondent's two most recent FITREPs and averaged.

- Personal awards and decorations

The score for awards is calculated using the type and quantity of the highest and second highest personal decorations each officer received. Points are assigned from one to five for the type of award, depending on the order of precedence. The points per award are multiplied by the quantity received. This is done for the

officer's highest and second highest awards and added together to get the "total award value." The values assigned in this sample were:

<u>Award</u>	<u>Value</u>
Navy Achievement Medal	1
Service Commendation Medal	2
Joint Commendation Medal	3
Meritorious Service Medal	4
Defense Meritorious Service Medal	5
Bronze Star	6
<ul style="list-style-type: none"> • If an officer has achieved of the following benchmark qualifications: <ul style="list-style-type: none"> • Surface Warfare Officer (SWO) • Engineering Officer of the Watch (EOOW) • Tactical Action Officer (TAO) • Command Duty Officer (CDO) 	

Years of active duty service, number of deployments, number of platforms served on, average relative FITREP score, and total award value are normalized using min-max normalization to assign each respondent a value from 0 to 1 in each category.

Method 1 assigns equal weight (1) to each metric. The following is an example of the calculation for an officer's quality rating using method 1:

Q1. How many total years of active duty service do you have?

Answer: **13.**

Q2. How many deployments (>90 days) have you completed?

Answer: **4.**

Q3. How many different platforms have you been stationed on?

Answer: **5.**

Q4. Have you completed at least one “topside” AND engineering tour?

Answer: **Yes.**

Q6. From your most recent OBSERVED FITREP, please enter:
Member Trait Average and Summary Group Average.

Answer: **5.00, 4.71.**

Q7. From your second most recent OBSERVED FITREP, please enter:
Member Trait Average and Summary Group Average.

Answer: **4.83, 4.81.**

Q8. What is the highest U.S. military personal decoration / award
you’ve received? And, how many?

Answer: **Navy Commendation Medal, 3.**

Q9. What is the second highest U.S. military personal decoration /
award you’ve received? And, how many?

Answer: **Navy Achievement Medal, 5.**

Q10. Which of the following personal qualifications do you have,
Surface Warfare Officer (SWO), Engineering Officer of the Watch (EOOW), Tactical
Action Officer (TAO), Command Duty Officer (CDO)?

Answer: **SWO, EOOW, TAO, CDO**

Table 7 demonstrates the calculation for Quality Method 1.

Table 7. Quality Method 1 Calculation

Metric	Response	Metric (M_i) (Normalized Value)	Weight (W^n)	Weighted Value	Max Points
Years of Service	13	0.464	1	0.464	1
# Deployments	4	0.333	1	0.333	1
# of Platforms	5	1	1	1	1
Topside and Eng. Tour	Yes	1	1	1	1
Average Relative FITREP	1.024	0.305	1	0.305	1
Total Award Value	11	0.733	1	0.733	1
SWO Qualification	Yes	1	1	1	1
EOOW Qualification	Yes	1	1	1	1
TAO Qualification	Yes	1	1	1	1
CDO Qualification	Yes	1	1	1	1
Sum				7.835	10

$$q_i = 5 \times \left(\frac{7.835}{10} \right) = \mathbf{3.918}$$

b. Quality Method 2

Quality Method 2 uses all of the same metrics as Quality Method 1, but assigns different weights to each category. Table 8 illustrates the respective weights assigned to each category and the calculation for Quality Method 2 using the same questions and answers as above.

Table 8. Quality Method 2 Calculation

Metric	Response	Metric (M_i) (Normalized Value)	Weight (W^n)	Weighted Value	Max Points
Years of Service	13	0.464	1	0.464	1
# Deployments	4	0.333	2	0.666	2
# of Platforms	5	1	1	1	1
Topside and Eng. Tour	Yes	1	1	1	1
Average Relative FITREP	1.024	0.305	5	1.525	5
Total Award Value	11	0.733	3	2.199	3
SWO Qualification	Yes	1	1	1	1
EOOW Qualification	Yes	1	2	2	2
TAO Qualification	Yes	1	3	3	3
CDO Qualification	Yes	1	2	2	2
Sum				14.854	21

$$q_i = 5 \times \left(\frac{14.854}{21} \right) = 3.537$$

c. Quality Method 3

Quality Method 3 narrows the metrics to years of service, number of platforms, completing a topside and engineering tour, average relative FITREP score, EOOW, TAO, and CDO qualifications. It assigns an equal weight to each metric used. Table 9 demonstrates the calculation for Quality Method 3 using the same questions and answers as the previous two examples.

Table 9. Quality Method 3 Calculation

Metric	Response	Metric (M_i) (Normalized Value)	Weight (W^n)	Weighted Value	Max Points
Years of Service	13	0.464	1	0.464	1
# of Platforms	5	1	1	1	1
Topside and Eng. Tour	Yes	1	1	1	1
Average Relative FITREP	1.024	0.305	1	0.305	1
EOOW Qualification	Yes	1	1	1	1
TAO Qualification	Yes	1	1	1	1
CDO Qualification	Yes	1	1	1	1
Sum				5.769	7

$$q_i = 5 \times \left(\frac{5.769}{7} \right) = \mathbf{4.121}$$

d. Quality Method 4

Quality Method 4 uses the same metrics as Quality Method 3. However, it assigns different weights to each metric used. Table 10 illustrates the respective weights for each metric and the calculation for Quality Method 4 using the same questions and answers as the previous three examples. For the purposes of this thesis, quality scores are calculated using Quality Method 4. This method is the simplest way to adequately estimate an officer's quality, value, and future performance to the Navy utilizing the survey data available.

Table 10. Quality Method 4 Calculation

Metric	Response	Metric (M_i) (Normalized Value)	Weight (W^n)	Weighted Value	Max Points
Years of Service	13	0.464	1	0.464	1
# of Platforms	5	1	1	1	1
Topside and Eng. Tour	Yes	1	1	1	1
Average Relative FITREP	1.024	0.305	5	1.525	5
EOOW Qualification	Yes	1	2	2	2
TAO Qualification	Yes	1	3	3	3
CDO Qualification	Yes	1	2	2	2
Sum				10.989	15

$$q_i = 5 \times \left(\frac{10.989}{15} \right) = 3.663$$

E. QUALITY METHOD COMPARISON AND SCORES

When each quality method is applied to the sample, the scores are highly correlated. This suggests that scores produced by one are likely to be similar to the scores produced by other methods. Tables 11 and 12 show the summary statistics of each of the quality methods and the correlation between them.

Table 11. Quality Method Summary Statistics

	Quality Method 1	Quality Method 2	Quality Method 3	Quality Method 4
Mean	2.697	2.314	2.727	2.406
Standard Error	0.080	0.077	0.091	0.083
Median	2.618	2.221	2.756	2.319
Mode	N/A	N/A	3.518	2.638
Standard Deviation	0.836	0.797	0.948	0.866
Sample Variance	0.698	0.635	0.898	0.750
Kurtosis	-0.333	-0.589	-0.482	-0.562
Skewness	-0.181	0.053	-0.180	0.021
Range	4.057	3.562	4.133	3.700
Minimum	0.327	0.373	0.329	0.386
Maximum	4.384	3.935	4.462	4.086
Count	108	108	108	108
Largest (5)	3.987	3.594	4.252	3.874
Smallest (5)	1.212	0.944	1.018	0.835
Confidence Level (95%)	0.159	0.152	0.181	0.165

Table 12. Quality Method Correlation

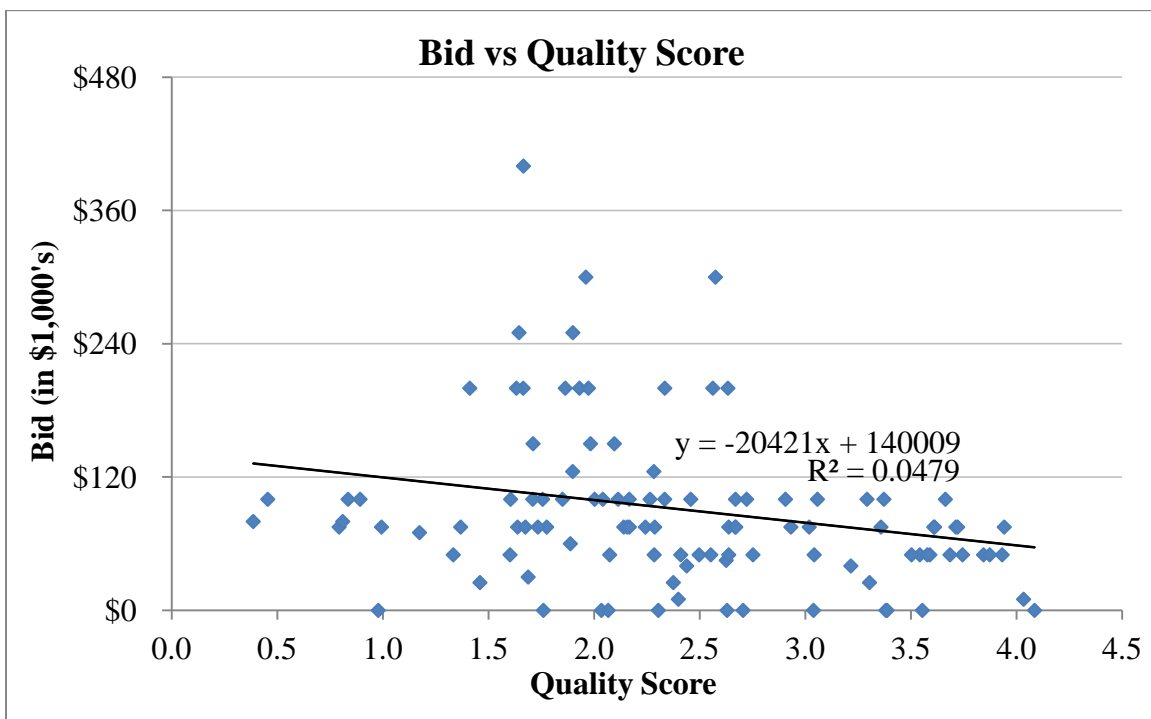
	<i>Quality Method 1</i>	<i>Quality Method 2</i>	<i>Quality Method 3</i>	<i>Quality Method 4</i>
<i>Quality Method 1</i>	1			
<i>Quality Method 2</i>	0.97	1		
<i>Quality Method 3</i>	0.98	0.96	1	
<i>Quality Method 4</i>	0.93	0.97	0.96	1

The results of the survey are inconsistent with the hypothesis that higher quality bidders carry higher reservation values or bids. This is likely due to the self-selection bias present in the voluntary survey. Officers opting into the survey are likely to have lower reservation values than officers choosing not to participate; if they are motivated enough and willing to participate in a voluntary survey, they are may be more motivated about military service and contributions to research.

In addition, the quality scores are heavily dependent on experience and time in service. Number of platforms served on, deployments completed, variety of tours completed, personal awards, and qualifications received often increase over time,

increasing quality scores for officers with more time in service. Officers with more time in service are also closer to retirement and qualification for the associated benefits, likely lowering their reservation values for remaining on active duty. The correlation between the bids and quality score was -0.219. Figure 1 is the graph of the bids versus quality score. The r-square of 0.0479 indicates the data is not perfectly linear, and the slope of -20,421 indicates bids decrease by roughly \$20,000 for every 1 point increase in quality rating.

Figure 1. Bid Versus Quality Score



VI. ANALYSIS AND RESULTS

A. INTRODUCTION

Once the bids and quality scores are estimated from the survey data, the parameters are entered into four models in Microsoft Excel to conduct simulation runs. The first model represents the current bonus system, simply setting the SWO Bonus equal to \$75,000. The second model utilizes a standard-uniform price auction, and attempted to retain 34% of the bids submitted. The third model is a QUAD Auction optimized to minimize cost, and the fourth model is a QUAD Auction optimized to maximize the median quality of the officers retained. The total cost, median quality, and quantity of offices retained by each model are used to evaluate the potential cost savings and quality increases by each model against the current system.

B. MODEL RESULTS ANALYSIS

The survey data produced 108 usable bids or participants. In order to most accurately model the retention goals and behavior of the SWO community, the simulations attempt to retain 37 officers, 34% of the 108 participants. The SWO community currently assesses approximately 800 officers each year to meet its goal of 275 SWO department heads, 34% of the officers assessed, by the 7 year mark. Table 13 summarizes the quantity, quality, and cost of the officers retained by each model.

Table 13. Retention Results by Model

Mechanism	Current System	Standard Uniform Price Auction	QUAD Auction (Min Cost)	QUAD Auction (Max. Quality)
Quality Discount Threshold (q^*)			2	3
QUAD Allowance (A)	-	-	\$ 20,250	\$ 75,250
Number Retained	65	37	37	37
Average Cost	\$ 75,000	\$ 60,000	\$ 48,608	\$ 83,979
Total Cost	\$ 4,875,000	\$ 2,400,000	\$ 1,798,500	\$ 3,107,250
Median Quality	2.64	2.80	2.90	3.23

* Sample size 108

* Retention Target 37 (34%)

1. Current SWO Bonus and Retention System

The current SWO Bonus and retention mechanism is used as a baseline for comparison against the standard uniform-price auction and two QUAD auctions. \$75,000, the current total SWO Bonus, is used. Any officer with a reservation value or bid less than or equal to \$75,000 is retained. This is how the current system functions, any officer willing to accept the SWO Bonus and complete two SWO Department Head tours is retained and paid the bonus.

This model retains 65 officers, 75% more than the targeted 37. The total and average costs of the current system produced by the model are \$4,875,000 and \$75,000, respectively. The average cost is important to note for comparison sake, since the model over retains. The median quality of officers retained by the current system is 2.64.

While the current system historically suffers from under retention in practice, it suffers from over retention in this study. The inability to control for the quantity of officers retained is an inherent weakness and inefficiency of the current retention mechanism; it can produce manpower shortages or excess costs. The over retention in

the model is caused by self-selection bias in survey. Participants likely have a higher propensity to accept the SWO Bonus and remain on active duty than officers declining to participate in the survey, skewing the retention rate in the sample compared to the population.

2. Standard Uniform-Price Auction

The standard uniform-price auction ranks the officer's bids, retains the 37 lowest bids, and pays the retained officers the 38th lowest bid (first excluded bid). The total and average costs of the standard uniform-price auction model are \$2,400,000 and \$60,000, respectively. The median quality is 2.80.

While the current system model has significant over retention, the standard uniform-price auction retains exactly 37 officers. The standard uniform-price auction provides \$2,475,000 or 50.77% savings over the current system in total costs. Although much of these savings result from precisely achieving the retention target, the average cost per officer retained also decreases from \$75,000 to \$60,000, or 20%.

3. Quality Adjusted Discount Auction (Optimized to Minimize Cost)

In total, 2,185 simulation runs varying q^* and A are made using Excel data tables to minimize the total cost. The simulations find the minimum cost is obtained by setting q^* to 2 and A to \$20,250. Officers with a quality level greater than or equal to 2 have their bids discounted by \$20,250. Like the standard uniform-price auction, the QUAD model retains exactly 37 officers. The total and average costs are \$1,798,500 and \$48,608, respectively. The median quality of the officers retained 2.90.

This QUAD model increases the quality 9.85% and 3.57% over the current system and standard uniform-price auction, respectively. In addition to the quality increases, this model produces a total cost savings of \$3,076,500 or 63.1% over the current system.

4. Quality Adjusted Discount Auction (Optimized to Maximize Quality)

By altering the quality discount threshold, q^* , and the assistance level, A , community, compensation, and bonus managers have the flexibility to balance the quality of the officers retained against the total retention costs. To demonstrate this flexibility and control, the 2,185 simulations are run again to find the q^* and A that produce the highest average quality rating. The simulations find the highest average quality rating is realized by setting q^* to 3 and A to \$75,250. Officers with a quality level greater than or equal to 3 have their bids discounted by \$75,250. This QUAD model also retains exactly 37 officers. The total and average costs are \$3,107,250 and \$83,979, respectively. The median quality of the officers retained 3.23.

This QUAD model increases the quality 22.3% over the current system. In this study, this is the equivalence of an officer with member trait averages 15% above summary group averages. This model's total cost is still \$1,767,750, or 36.3% lower than the current system.

C. CHAPTER SUMMARY

The results of the simulations demonstrate that auction mechanisms give manpower planners the ability to control for the quantity of officers retained. All three auction mechanisms, the standard uniform-price and both QUAD auctions, achieve the exact retention target in each of the models.

In addition, QUAD auctions give community, compensation, and bonus managers additional flexibility to control for quality. Both QUAD auctions, minimum total cost and maximum quality, increase the quality to 2.90 and 3.23, respectively, while still saving money over the current system. The QUAD auction designed to minimize total costs achieves a 63.1% cost savings over the current system, and the QUAD auction optimized to maximize quality increases quality 22.3% over the current system.

VII. SUMMARY, CONCLUSIONS AND RECOMMENDATION

A. SUMMARY

The purpose of this study is to explore the potential benefits of utilizing a unique quality adjusted discount (QUAD) auction to assign retention bonuses. The study analyzes the impact of auction mechanisms on the quantity, quality, and cost of retaining Surface Warfare Officers utilizing survey data of 327 former, current, and future SWO Bonus-eligible officers from the Naval Postgraduate School and on ships throughout the Pacific Fleet. Reservation values or bids and quality ratings are estimated using the survey data to conduct several simulations and comparisons between the current SWO Bonus retention mechanism, a standard uniform-price auction, and QUAD auctions. The methodology is similar to White (2010) and Pearson (2011), but uses survey data and focuses solely on retention and the US Navy.

The results from this thesis could be used by community, compensation, and bonus managers in the future to more efficiently shape the force. Manpower managers will have the flexibility to balance the quantity and quality of the officers retained against the costs.

B. CONCLUSIONS

The study and simulations demonstrate efficiency improvements over the current retention system. The thesis supports the findings from previous research on QUAD auctions, and confirms the hypothesis that increases in quality do not necessarily create cost increases (Table 13).

The reservation values estimated from the survey have a weak and nonlinear, but negative, correlation between an officer's quality rating (Figure 1). This is likely due to the combination of metrics used to determine quality and self-selection bias from the voluntary survey.

The flexibility to control for quantity produces cost savings for the Navy in two ways. First, the Navy can precisely meet retention targets, eliminating manning shortages associated with under retention, and excess costs from over retaining. Second,

market design and auction mechanisms allow the Navy to alter its accession policies. The Navy currently assesses significantly more junior officers than it requires to accommodate lateral transfers and attrition that occurs over time. Initially, over-assessing personnel carries significant recruiting, training, and labor costs. Uniform price auctions allow the Navy to tailor its accession numbers to its current manning needs instead of over accessing in hopes of meeting retention goals years later.

In addition to controlling the retention quantity, auction mechanisms endogenously determine the lowest cost. The current bonus and retention system is based on historical trends and predictions of how much to offer servicemembers to retain. Auctions utilize voluntary participation and actual reservation values from the bidders to determine the servicemember supply curve. Compensation and bonus managers can use the known reservation values and corresponding supply curve along with the retention target to find the optimal retention bonus required.

Finally, quality discount auctions allow the Navy to control for the quality of the force. Manpower planners can opt to “buy” more or less quality by altering the quality discount threshold and assistance level provided. This allows the Navy to maximize quality within budgetary constraints.

C. RECOMMENDATIONS

This study uses survey data to build on previous models. Experimental data from a controlled environment can mitigate the issues associated with survey data, and allow for more rigorous testing of the QUAD mechanism. A laboratory environment will allow facilitators to explain the rules of the auction and implications of attempting to under or over bid actual reservation values to the participants. Upon completion of experimental or laboratory evaluations, QUAD auctions should be implemented in small communities prior to wide-scale implementation.

Ultimately, the quality metrics, quality discount threshold, and assistance level used by the QUAD mechanism are policy questions. Assistance from community, compensation, and bonus managers will be required to identify the appropriate metrics and levels to use to optimize the outcome.

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APPENDIX A. AUCTIONS

The following is an excerpt from a thesis written by Tony K. Verenna (2007) while attending the Naval Postgraduate School.

TYPES OF AUCTIONS

1. Ascending-Bid (English Auction)

This type of auction is the most common. It involves bidders raising the price until only one buyer is left. This auction can be run three ways: 1. The seller announces prices, 2. the bidders call out their prices, or 3. bids can be submitted electronically with the best current price listed (Klemperer, 2004).

2. Descending-Bid (Dutch Auction)

This type of auction is exactly the opposite of the ascending-bid auction. In this scenario, the price starts out higher than any buyer is willing to pay and lowers continuously until the first bidder is willing to accept the good at the current price (Klemperer, 2004).

3. First-Price Sealed Bid

This type of auction consists of each bidder submitting their bid without the knowledge of the other bidders. In this scenario, the good goes to the bidder who has submitted the highest bid and the winner pays the price they bid (Klemperer, 2004).

4. Second-Price Sealed Bid

This type is very similar to the first-price sealed bid auctions. In this scenario, the winner is still the bidder who has submitted the highest bid; however, the bidder only has to pay the price of the second highest (or first excluded) bid (Klemperer, 2004).

KEY FEATURES

1. Forward Versus Reverse

a. Forward Auction

A Forward Auction is the most common form of auctioning and one that is most familiar. It involves a single seller of a good and multiple buyers bidding for the right to purchase that good. Usually the winner of this type of auction is the bidder who submits the highest bid.

b. Reverse Auction

A reverse auction consists of one buyer and multiple sellers vying for a specific good. In a reverse auction, the winner is the bidder with the lowest bid.

2. First-Price Versus Second-Price Bidding Strategies

a. First-Price

In a forward auction, the winning bidder pays what he bid for the item; in a reverse auction the bidder gets paid what he bid. In the forward auction, if the bidder wins the auction that is below his private-value, then he receives a profit. In a reverse auction, the bidder who wins the auction above his reserve price receives a surplus. Bidders can use information or “signals” to determine the amount they are going to bid to maximize their profit or surplus. Bidders will under bid their true valuation in a forward auction and they will bid above their true valuation in a reverse auction.

b. SecondPrice

In a forward auction, the winning bidder pays an amount equal to the second highest bid. In a reverse auction, the winner is paid an amount equal to the first non-winning bid. In each case, one’s bid is only used to determine if he is the winner. The amount the bidder pays or gets paid depends on the bids of others. In both types of auctions, the dominant strategy is for each bidder to submit a bid equal to their true valuation of the item.

3. Common Value versus Independent Private-Value

a. Common Value

The value of the item is common or the same for each bidder; however, bidders have different private information about what the value actually is. For example, the value of land that supposedly has oil underground will have the same value to any buyer who plans to drill the oil. Bidders may have access to different “signals” about the amount of oil located underground, so they may have different perceptions about its common value. In this case, bidders might change their estimate if they learned of another bidder’s signal.

b. Independent Private-Value

The value of the item is whatever the individual bidder values the item to be. This information is private to the bidder. This does not preclude bidders from changing their bid to gain an advantage once they find out the bids of others. An example of this would encompass a contractor bidding on a job. The contractor knows what the job will likely cost him; however, he does not know what it will cost other contractors.

4. Open Versus Sealed-Bid

a. Open Auctions

An open auction consists of the bidders knowing the competitions’ bids. Bids can be called out by an auctioneer, the bidders can call out their bids, or a bid can be posted electronically. The key to an open auction is that bidders know what others are bidding.

b. Sealed-Bid

In a sealed-bid auction, the bidder only knows his bid. All bids are submitted somewhat simultaneously as each bidder submits one bid. In this case, the bidders must estimate what other bidders may bid to maximize their chances of winning.

FACTORS WHEN DECIDING AUCTION FORMAT

Several factors need to be considered when deciding on the type of auction to be used. The objectives may differ for each seller in different auctions. According to the Revenue Equivalence Theorem (RET), the design of the auction does not matter as each type generally yields the same revenue for the seller. The following factors should be considered when designing an auction:

1. Revenue Equivalence

According to the RET, all four types of auctions yield the same revenue on average under the following assumptions:

- Bidders are risk neutral
- Independent private-values assumption applies
- Symmetric bidders (each draws from similar probability distributions)
- Payment is based only on bids

If these four criteria are met, it does not matter which design is chosen and the expected value for each auction will be generally the same. For example, the English and second-price sealed-bid auctions will yield the same revenue as the winner pays the second highest value. In the Dutch and first-priced sealed-bid auctions, the winner will attempt to outbid his competition by the slightest value to maximize his economic rent. By meeting the four criteria described above, the RET would prove to be correct. However, most auctions will fail to meet the criteria of the RET and bidders tend to act differently within each design. Klemperer raises the issue of collusion and the attractiveness to potential bidders as reason for susceptibility. An auction designer needs to understand the purpose of the auction to design it correctly.

2. Risk Tolerance among Bidders

Information is a key aspect in all forms of auctions. In the open form auctions, bidders can view their competitors' bids; whereas, in sealed bid auctions, the bidder is

dependent on the information he has gathered to submit a bid based on his value. The amount of information or lack of information creates uncertainty and risk.

Generally, a risk neutral bidder's behavior is not affected by an increase in risk, and, therefore, such a bidder will approach all types of auctions in the same manner. On the other hand, most individuals are risk averse and will attempt to decrease their risk and increase their certainty. A risk averse person will tend to bid more aggressively to increase the probability of winning and reduce the uncertainty. This also would decrease the surplus value received from the product if a risk-averse individual is the winning bidder. Risk averse bidders will typically generate higher values for the sellers in the Dutch and first-price sealed bid auctions compared to the English and second-price sealed bid auctions.

3. Collusion

Individual bidders would like to collude in auctions to keep prices at a minimum. In open auctions, collusion could occur through signals among bidders or through the bid itself, especially if the product is of value to the bidder. In addition, a bidder who is not cooperating with a colluder could be forced into paying a much higher price for an item than if the bidder had cooperated. In sealed-bid auctions, collusion is very rare as there is no communication between the players in the bidding process; collusion requires pre-agreement concerning the sealed bids. A seller would obviously attempt to thwart collusion, using one of the following options. First, the seller can set a reserve price (see below). Second, if the seller becomes aware that collusion is occurring, the item being auctioned can be removed and saved for another day. Third, an auctioneer could remove suspected colluders from the auction. Finally, an auctioneer could revert to unethical practices and utilize a ghost bidder to raise the price of an auction.

4. Reserve Price

For a seller to guarantee an appropriate profit, he may set a reserve price. This is a minimum price (forward auction) or maximum price (reverse auction) set at the outset to guarantee minimum revenue or maximum cost. These prices must be set carefully so they don't discourage potential bidders from bidding. For example, in a forward auction a

seller could set a reserve price of \$500 for an item when a bidder values that item to be \$400. As a result, this potential bidder would not participate in this auction. If this reserve price scares off all potential bidders, the seller would lose his sale even though he could have potentially received his value through the auction.

Setting reserve prices could also deter collusion. If the seller sets his price to receive a profit, he will get bids assuming the price is not too high. It would not matter if colluders minimized the value or the bids; the seller would still receive some profits. Overall, setting a reserve price would reduce the incentive for bidders to cooperate.

5. Private Information

As stated previously, information is a key aspect to an auction. Information would include knowledge of the product or service, quantity available, historical sales, or competition involved. The value of an item to an individual could differ depending on how much he knows about that item. Auctioneers tend to provide information that would increase the bids to increase revenue. On the other hand, certain information may cause bidders to revise their bids downward. An auctioneer or seller must decide what and how much information to divulge to the bidder.

Information can also increase uncertainty. If a seller releases certain information that may cause a bidder to increase his value of an item, then the risk averse bidder would increase his bid to increase his probability of winning the item.

6. Number of Bidders

An increase in competition or the number of bidders usually increases the seller's revenue. In this case, it would be to the seller's benefit to increase participation in an auction. This could also serve the purpose of a reserve price. In Dutch and first-price sealed bid auctions, more bidders tend to generate higher bids for an item as increased competition (uncertainty) and risk aversion cause participants to alter their bids; whereas increased competition in an English or second-price sealed bid auction would not change the bidding strategy, as the bidder only bids his value of an item regardless of the

competition (however, the highest and second highest valued bids are likely to increase with increased participation).

7. Other Factors

Auction design can be influenced by other factors. These include: entry fees to participate in an auction, time limits instilled for the auction, and a middleman representing the bidder.

Entry fees could be charged to participate in an auction. This could separate those undesirable bidders from the more serious bidders. In addition, an entry fee resembles a reserve price, as those with low valuations of an item would be excluded. One drawback to an entry fee, especially in an assignment or bonus setting, would be that individual bidders would tire of submitting bids if it becomes non-refundable and the guarantee of return dwindles.

Time limits would control the amount of information that individual bidders could collect on other bidders to determine their value of an item or a competitor's bidding strategy. Time limits would also increase uncertainty. As stated previously, a risk averse participant would bid more aggressively to decrease uncertainty. A tight time limit imposed on an assignment or bonus auction for the military would not necessarily be suitable. Military personnel are dispersed throughout the world and information on auctions and ways to submit bids may not always be available in a timely manner.

The last factor to consider is that of the middleman. A middleman could represent the bidder. To do this, the middleman must know the bidder's valuation and must definitely know the bidder's maximum bid in a forward auction and the minimum bid in a reverse auction. Also, it would be in the best interest of both the seller and the bidder for the middleman to know some information about the item up for bid. A positive aspect of the middleman includes the fact that military personnel could still participate in an auction no matter what their geographical or technological status, assuming they understand the previous issues.

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APPENDIX B. SURVEY QUESTIONS

Quality Adjusted Auction Mechanism: Survey

Introduction and Consent to Participate

You are invited to participate in a research study entitled Quality Adjusted Auction Mechanism: Survey. The purpose of the research is designed to consider various ways of improving the current bonus system for force structure, such as the Surface Warfare Officer Continuation Pay (SWOCIP), without sacrificing the quality of officers retained. Analysis of this survey will assist the NPS researchers and student thesis.

This survey contains 69 questions, and should take about 30 minutes to complete. Some questions will ask you to reference your past 4 FITREPS. We expect approximately 250 participants.

There is no cost to participate. Alternative to participating is to not participate. If you choose to participate, you are free to skip any questions or stop participating at anytime without penalty. Your responses are anonymous. There is no direct personal benefit to you for participating in the survey.

Results of the survey will be used responsibly and protected against release to unauthorized persons; however, there is a minor risk that data collected could be mismanaged. All data collected will be stored on a secure computer at NPS, and any hardcopy will be kept in a secure file cabinet. Only the researchers will have access to the survey data. Additionally, your personal information will not be available to the researchers.

If you have questions regarding the research, contact Dr. Noah Myung, 831-656-2811, noah.myung@nps.edu or LT Jason Nowell at jtnowell@nps.edu. If you have any questions regarding your rights as a research subject, please contact the Naval Postgraduate School IRB Chair, CAPT John Schmidt, jkschmid@nps.edu, 831-656-3864.

I have read the consent to participate form and understand the content of this survey.

☐ Yes

☐ No

Quality Adjusted Auction Mechanism: Survey

Have you ever worked as a civilian?

☐ Yes

☐ No

If yes, where?

Have you been contacted by a “head-hunter” or civilian company for post-military employment opportunities?

☐ Yes

☐ No

Have you researched civilian employment opportunities since joining the Navy?

☐ Yes

☐ No

If yes, how and to what extent?

How long do you think it would take you to find a job if you were to get out of the military (please answer in months)?

What career field would you pursue if you decided to leave the military right now (or as soon as possible)?

What do you think the average annual salary is in the civilian sector you would pursue?

How much more or less do you think you would make compared to the average salary in the civilian sector you choose (if you, in fact, decided to leave the military)?

☐ Much more

☐ Little more

☐ About average

☐ Little less

☐ Much less

Quality Adjusted Auction Mechanism: Survey

HOW LIKELY do you think it is that you will make **AT LEAST \$97,000?**

- ☐ Very likely
- ☐ Somewhat likely
- ☐ Neutral
- ☐ Somewhat unlikely
- ☐ Very unlikely

What is your EXPECTED annual salary of post-military civilian position, if you left the military today?

What is the MINIMUM salary you would need to be offered for a civilian position in order to leave the military service today?

In your current rank, how would you rate your total compensation (Including base pay, BAH, BAS, medical and life-insurance, and all other benefits)?

- ☐ Very satisfied
- ☐ Satisfied
- ☐ Neutral
- ☐ Dissatisfied
- ☐ Very dissatisfied

How valuable to you is your current total compensation package (in dollars, annual basis)?

What is the MINIMUM BONUS you would need to be offered by the Navy to commit to 2 Department Head Afloat tours?

If you had to decide today, would you make a career (20 years or longer) in the Navy?

- ☐ Yes ☐ No

If yes, why?

Quality Adjusted Auction Mechanism: Survey

What is the most influential reason for STAYING in the military (pick the one best answer)?

- ☐ Education opportunities
- ☐ Patriotism
- ☐ Pay
- ☐ Pension/Retirement plan
- ☐ Job security
- ☐ Healthcare
- ☐ Job satisfaction
- ☐ Other (please specify)

What is the most influential reason for LEAVING the military (pick the one best answer)?

- ☐ Education opportunities
- ☐ Patriotism
- ☐ Pay
- ☐ Pension/Retirement plan
- ☐ Job security
- ☐ Healthcare
- ☐ Job satisfaction
- ☐ Other (please specify)

Do you own your own business or have a second job while off-duty?

- ☐ Yes
- ☐ No

Which of the following best describes the current financial situation for you and your spouse?

- ☐ Very comfortable and secure
- ☐ Comfortable – able to make ends meet without much difficulty
- ☐ Somewhat uncomfortable – occasionally have some difficulty making ends meet
- ☐ Uncomfortable – Tough to make ends meet, but keeping head above water
- ☐ Very uncomfortable – in over your head

Quality Adjusted Auction Mechanism: Survey

Would you be willing to take a pay cut to leave the military?

☐ Yes

☐ No

If yes, how much?

Are you willing to work more hours as a civilian than you do now?

☐ Yes

☐ No

If yes, how many hours/week are you willing to work?

Do you hold any professional civilian qualifications or licenses?

☐ Yes

☐ No

If yes, what are they?

If you were looking for a civilian job, what would be the most important factor you considered?

Quality Adjusted Auction Mechanism: Survey

Are you proficient in another language?

☐ Yes

☐ No

If yes, what is your DLPT score (if you have one)?

Have you ever held any staff positions/billets?

☐ Yes

☐ No

Have you ever completed an IA/GSA billet?

☐ Yes

☐ No

What is the highest U.S. military personal decoration / award you've received?

Decoration / Award:

How many you've received:

What is the second highest U.S. military personal decoration / award you've received?

Decoration / Award:

How many you've received:

How many division officer (afloat) tours have you completed?

How many acting department head (afloat) tours have you completed (greater than 45 days)?

How many department head (afloat) tours have your completed?

☐ N/A (due to year of commissioned service or lateral transfer)

☐ 0

☐ 1

☐ 2

How many deployments (>90 days) have you completed?

Quality Adjusted Auction Mechanism: Survey

How many total months have you been deployed in your career (IA/GSA included)?

How many different platforms have you been stationed on?

- ☐ N/A (due to year of commissioned service or lateral transfer)
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

Have you completed at least one “topside” AND engineering tour (either as a division officer or department head)?

☐ Yes

☐ No

From your most recent OBSERVED FITREP, please enter: Member Trait Average, Summary Group Average, Soft Breakout (Block 41), Recommendation(s)

Member Trait Average (Block 45) [e.g. 4.61]

Summary Group Average (Block 45) [e.g 4.21]

Soft Breakout (Block 41) [e.g. 1 of 12, 2 of 12, No, or unsure]

Recommendation (Block 40) [e.g DEPT HEAD AFLOAT]

Additional Recommendation (Block 40) [e.g LT/LCDR CMD]

From your second most recent OBSERVED FITREP, please enter: Member Trait Average, Summary Group Average, Soft Breakout (Block 41), Recommendation(s)

Member Trait Average (Block 45) [e.g. 4.61]

Summary Group Average (Block 45) [e.g 4.21]

Soft Breakout (Block 41) [e.g. 1 of 12, 2 of 12, No, or unsure]

Recommendation (Block 40) [e.g DEPT HEAD AFLOAT]

Additional Recommendation (Block 40) [e.g LT/LCDR CMD]

Quality Adjusted Auction Mechanism: Survey

From your third most recent OBSERVED FITREP, please enter: Member Trait Average, Summary Group Average, Soft Breakout (Block 41), Recommendation(s)

Member Trait Average (Block 45) [e.g. 4.61]

Summary Group Average (Block 45) [e.g 4.21]

Soft Breakout (Block 41) [e.g. 1 of 12, 2 of 12, No, or unsure]

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From your fourth most recent OBSERVED FITREP, please enter: Member Trait Average, Summary Group Average, Soft Breakout (Block 41), Recommendation(s)

Member Trait Average (Block 45) [e.g. 4.61]

Summary Group Average (Block 45) [e.g 4.21]

Soft Breakout (Block 41) [e.g. 1 of 12, 2 of 12, No, or unsure]

Recommendation (Block 40) [e.g DEPT HEAD AFLOAT]

Additional Recommendation (Block 40) [e.g LT/LCDR CMD]

Have you ever failed a PRT?

☐ Yes

☐ No

If yes, how many?

Did you SWO non-attain?

☐ Yes

☐ No

Which of the following qualifications do you have? (select all that apply)

	YES	NO
OOD (U/W)	<input type="checkbox"/>	<input type="checkbox"/>
SWO	<input type="checkbox"/>	<input type="checkbox"/>
EOOW	<input type="checkbox"/>	<input type="checkbox"/>
TAO (from a CRUDES)	<input type="checkbox"/>	<input type="checkbox"/>
TAO (from a non-CRUDES)	<input type="checkbox"/>	<input type="checkbox"/>
CDO	<input type="checkbox"/>	<input type="checkbox"/>

If SWO qualified, how many months did it take you to get qualified?

Quality Adjusted Auction Mechanism: Survey

How do you rate your professional qualifications among your military peers

- ☐ Very competitive
- ☐ Somewhat competitive
- ☐ Neutral
- ☐ Somewhat less competitive
- ☐ Not competitive

How do you rate your professional qualifications among your civilian peers

- ☐ Very competitive
- ☐ Somewhat competitive
- ☐ Neutral
- ☐ Somewhat less competitive
- ☐ Not competitive

What level security clearance do you currently hold?

- ☐ TS
- ☐ Secret
- ☐ Confidential
- ☐ None

Do you plan on accepting, or have you already accepted SWOCIP and CRSB?

- ☐ Yes
- ☐ No
- ☐ N/A (No longer eligible)

Quality Adjusted Auction Mechanism: Survey

Suppose you had the option of receiving \$10,000 today (no strings attached). Further suppose that you had the option of instead receiving a larger dollar amount 1 year from now. What is the minimum dollar amount you would need to receive 1 year from now for you to be willing to choose that over receiving the \$10,000 today?

What is the minimum dollar you would need to receive 10 years from now for you to be willing to choose that over receiving \$10,000 today?

What is the minimum dollar you would need to receive 1 month from now for you to be willing to choose that over receiving \$10,000 today?

The current “SWO Bonus” is a combination of SWOCP and JCSRB. The typical payout schedule is:

	Years of Commissioned Service								
	4	5	6	7	7.5	8	8.5	9.5	10.5
Amount	\$10,000	\$0	\$15,000	\$5,000	\$10,000	\$5,000	\$10,000	\$10,000	\$10,000

Assuming the payout schedule and amounts do not change and you were to accept the SWO Bonus; would you prefer the current payout schedule or a one-time lump sum payment?

☐ The current schedule

☐ One-time lump sum

if a one-time lump sum, what is the minimum amount you would accept?

Quality Adjusted Auction Mechanism: Survey

Demographics

What was your commissioning source?

- ☐ USNA
☐ NROTC
☐ OCS
☐ STA-21
☐ ECP

What was your last civilian occupation, if any?

What is the highest degree you have earned?

- ☐ Bachelor's
☐ Master's
☐ Doctorate

What was your undergraduate major?

Where did you obtain your undergraduate degree?

What was your graduate major? (enter N/A if you don't hold a graduate degree, list all if more than 1)

Where did you obtain your graduate degree? (List all if more than 1)

What was your approximate cumulative undergraduate GPA?

Quality Adjusted Auction Mechanism: Survey

Are you male or female?

☐ Male

☐ Female

Which best describes your ethnic background?

☐ White

☐ Black

☐ Hispanic

☐ Asian

☐ Native American

☐ Other

What is your current marital status?

☐ Never married

☐ Married

☐ Divorced

☐ Separated

☐ Widowed

If divorced, how many times?

How many children do you have?

Is your spouse employed?

☐ Yes

☐ No

☐ N/A

If yes, what does he or she do?

What is your approximate current annual household income?

Quality Adjusted Auction Mechanism: Survey

What is your current pay grade?

- ☐ O1
- ☐ O1E
- ☐ O2
- ☐ O2E
- ☐ O3
- ☐ O3E
- ☐ O4

Are you a prior enlisted officer?

- ☐ Yes
- ☐ No

How many total years of active duty service do you have?

What is your current age?

What is your warfare designator?

- ☐ 1160
- ☐ 1110
- ☐ Laterally transferred to another community from 1110
- ☐ Laterally transferred to another community from 1160

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